

# THERMAL NEUTRON CAPTURE CROSS SECTIONS OF $^{44}\text{Ti}$ , $^{68}\text{Ge}$ , and $^{148}\text{Gd}$

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One of the basic properties of a nucleus is its neutron capture cross section. This quantity determines the rate at which a nucleus can be destroyed by neutron exposure. Knowledge of such cross sections is extremely important in calculations of the abundances of nuclei that emerge from astrophysical environments in which free neutrons are present. Techniques now being proposed to transmute long-lived radioisotopes into shorter lived ones also require knowledge of these cross sections. Over the years, thermal neutron capture cross sections have been measured for essentially all of the stable isotopes. There is currently a great deal of interest in nuclear astrophysics and other areas of nuclear physics in cross sections measurements on radioactive nuclei. However, there is very little experimental data on neutron-capture cross sections for radioactive nuclei. Thus, we have begun a series of measurements of thermal (n, $\gamma$ ) cross sections on long-lived radioisotopes using an activation technique. In the cases we have chosen, the addition of one neutron to the target nucleus produces a short-lived nuclide whose decay can be measured by  $\gamma$ -ray counting. The first three isotopes that we have studied are  $^{44}\text{Ti}$ ,  $^{68}\text{Ge}$ , and  $^{148}\text{Gd}$ .

We performed these experiments at the Oregon State University 1-MW TRIGA reactor facility. In each case, a measured quantity of the target of interest was irradiated in a flux of  $1 \times 10^{13}$  thermal neutrons/cm<sup>2</sup>-sec. The integrated flux that each sample was exposed to was measured by using iron flux monitors. After irradiation, gamma rays from the radioactive decays of

each sample were measured using a high-purity Ge detector. Data acquisition was performed using an ORTEC ADCAM PC-based system. Spectra were recorded in appropriate length time bins so as to follow the half-life of the isotope of interest. In the case of the  $^{44}\text{Ti}(n,\gamma)$  experiment, the decay of  $^{45}\text{Ti}$  produces only very weak characteristic  $\gamma$ -ray lines. However,  $^{45}\text{Ti}$  is a positron emitter with a half-life of 3 hours. Thus by measuring the decay curve of the 511-keV activity we could determine the amplitude of the 3-hour component. From this measurement we determined that the thermal neutron-capture cross section of  $^{44}\text{Ti}$  is  $1.1 \pm 0.2$  barns. For the  $^{68}\text{Ge}(n,\gamma)$  experiment, we measured the yield of the characteristic 1106-keV  $\gamma$ -ray produced in the decay of the 39-hour  $^{69}\text{Ge}$  activity. Analysis of the data from this experiment is now in progress. In the case of  $^{148}\text{Gd}(n,\gamma)$  we will measure the yields of the characteristic 150-, 299-, and 347-keV  $\gamma$  rays produced in the decay of the 9.3-day  $^{149}\text{Gd}$ .

## Footnotes and References

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